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ABSTRACT

Sixty subjects, 30 males and 30 females, grades 7-9, were given an estimation and comparison mathematics test consisting of high and low difficulty level problems. Performances as measured by total error scores were compared as functions of sex and anxiety separately for high and low difficulty problems. There was a significant main effect of anxiety on low difficulty level problems. However, anxiety did not have a significant effect on the high difficulty level problems. The results did not support the hypothesis of a sex and a sex-anxiety interaction effect on mathematics performance. (Author)

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The Effects of Sex and Anxiety on Mathematics Performance

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Abstract

Sixty subjects, 30 males and 30 females, grades 7-9, were given an estimation and comparison mathematics test consisting of high and low difficulty level problems. Performance as measured by total error scores were compared as functions of sex and anxiety separately for high and low difficulty problems. There was a significant main effect of anxiety on low difficulty level problems. However, anxiety did not have a significant effect on the high difficulty level problems. The results did not support the hypothesis of a sex and a sex-anxiety interaction effect on mathematics performance.

In the last few years the woman's liberation movement and equal opportunity programs have helped encourage research into the differences between the sexes. One area in which the differences are most pronounced is in the field of mathematics. For instance, Tobias (1978) found significantly fewer females than males pursuing mathematics related studies.

The reasons behind this finding are not often clear. Some researchers have tried to find sex related ability differences to account for female's apparent lack of interest in mathematics. Treagust (1980) found significant differences between adolescent males and females in spatial ability. Males had significantly more spatial ability than females. However not all of the literature agrees with Treagust's findings. Fennema and Sherman (1978) concluded that sex related differences in mathematics ability, including spatial ability in favor of males, do not appear often; and when they do, they are not large. Some research has even shown a difference in favor of females (Elmore and Vasue, 1980). In this study females had significantly higher positive attitudes toward mathematics and higher mean course grades in a college graduate level statistics course. The authors attributed this finding to the fact that the females scored high on a masculinity/femininity scale.

In view of these conflicting findings, some researchers have sought other explanations. Leder (1980) found that girls who are aware of social pressures associated with career choice and the negative consequences of contravening social conventions tended to have a lower performance level in mathematics than girls less concerned

with those issues. Sherman (1980) pointed out that while boys increase more so than girls in spatial skills, the difference was not significant. As a result, Sherman concluded that attitude and sex-stereotyping of mathematics as a male domain may play an important role in explaning why females fail to continue their education into mathematics. Furthermore, Donady and Tobias (1977) concluded that fear of mathematics and sex-stereotyping create a disproportion of mathematics-avoiding and mathematics-anxious females. This conclusion is supported by research (Sepie and Keeling, 1978) which found that females scored higher on a mathematics anxiety test than males. Also, Phillips (1967) found evidence that this difference between females and males in anxiety level originates at least at the first grade level. His findings showed that Anglos and females have higher school anxiety relation to failure in school than non-Anglos and males. Therefore, in view of the preceding studies, it might be concluded that, due to a variety of reasons, in mathematics females are more anxious than males.

The effects of anxiety on performance are well documented. Daniels and Hewitt (1978) found anxiety to have a highly consistent effect on performance across a variety of conditions with low anxiety groups scoring significantly higher than high anxiety groups. Results proved to be the same for males and females, when intelligence was held constant, and regardless of style of test question. Also item difficulty interacted with anxiety. As the item difficulty increased the superiority of the low anxious group over the high anxious group increased. Although anxiety does not affect all performance measures such as grade point average (Sassenrath, 1967),

anxiety does seem to play an important role in performance.

The purpose of the present study is to examine the effects of sex, anxiety, and item difficulty on performance as measured by a mathematics test. It is hypothesized that anxiety will have a significant effect on performance (i.e. more mistakes) and that that effect will be more pronounced in conjunction with females and a high difficulty level.

Methods

Subjects Sixty subjects, 30 males and 30 females, were randomly chosen from a population of seventh, eighth, and ninth grade students enrolled at Saybrook-Arrowsmith Jr-Sr High in Saybrook, Illinois. The males and females were then randomly assigned to one of two anxiety groups each containing 15 males and 15 females.

Materials A mathematics test of estimation and comparison was developed for the study. Eighty three-digit numbers were randomly chosen with the aid of an Apple II microcomputer. The numbers were randomly assigned to either high difficulty (HD) or low difficulty (LD) groups. Each group contained 40 numbers.

Sums (two three-digit numbers separated by an addition sign) were then generated for each number. A sum for the HD group was generated in such a way that its total was no more than a 10% difference higher or lower than its paired number. A sum for the LD group had a total of between a 10% to 90% difference higher or lower from its paired number. Exact percent differences and individual numbers were randomly chosen using the Apple II microcomputer.

The sum and paired number were randomly placed in one of two

columns. Placement of a pair on the test was also randomly determined.

Procedure Anxiety in the study was defined as a result of directions given to the two anxiety groups. Subjects in the high anxiety group (HA) were shown how to complete the test (i.e. writing the number of the column containing the larger value). It was stressed that the test would be graded and that the mathematics teacher would include the grade on the subject's report card. Subjects were required to sign their names and to indicate their sex on the test. Subjects were told that they had exactly four minutes to complete the test and that all unanswered questions would be treated as incorrect answers. Finally, the administrator of the test announced the remaining time in the testing period at the three minute, two minute, one minute, 45 second, 30 second, and 15 second marks. After completing the test, the subjects were informed of the purposes of the test and reassured that the results would not affect their grades.

Subjects in the low anxiety (LA) group were shown how to complete the test. They were told not to sign their names to the test but to indicate only their sex. Subjects were told that the test was not to be graded and was just an experiment that the administrator had to perform. Subjects were told to relax and to do their best. They were encouraged to work as fast as possible since they had only four minutes to complete the test. No announcements of remaining time were given during the testing period.

The total number of incorrect responses were coded for each subject for HD and LD problems separately. Questions left unanswered were not counted.

T-tests were performed to test if the difference between item difficulty levels were statistically significant. The purpose behind this being to show that the 10% difference level used to differentiate between LD and HD problems was valid. The tests compared LD and HD errors for the entire sample, for males only, and for females only. For the entire sample, significantly more mistakes were made on the HD problems than on the LD problems ($M=4.71$ versus $M=9.76$, $t=8.50$, $p < .001$). Results were similiar for the males only and females only comparisons ($M=5.87$ versus $M=10.57$, $t=5.38$, $p < .001$; $M=3.57$ versus $M=8.97$, $t=6.62$, $p < .001$ respectively).

The effects of sex and anxiety were examined separately for LD and HD problems. Table I presents the mean error scores and standard deviations of males and females under high and low anxiety for the LD and HD problems.

Insert Table I about here.

A 2x2 analysis of variance indicated significant effects for anxiety on LD problems ($F(1,56)=6.073$, $p < .02$). However, sex and sex-anxiety interaction were not significant.

No significant results were found using a 2x2 analysis of variance for sex and anxiety on HD problems.

Discussion

The results of the experiment support in part the results of Daniels and Hewitt (1980) in that anxiety did have a significant effect on performance on the LD problems. However, contrary to Daniels and Hewitt, the results were not significant for the effects

of anxiety on the HD problems. As items became more difficult (HD), the results for anxiety became non-significant. This may indicate that item difficulty has a maximum threshold effect beyond which anxiety has no effect. In other words, anxiety has a negative effect on performance as item difficulty increases; but after a certain point, the effect becomes non-significant. The problem simply becomes so difficult that subjects, regardless of anxiety level, make similiar errors. The 10% difficulty level used in this experiment may have fallen into this critical area. Due to the design of this experiment there were not enough problems in different difficulty levels to test for a critical level. Therefore, any definitive conclusions based on an item difficulty by anxiety interaction will have to wait for the results of future studies in the area.

The results of the study do not support the hypothesis of differences in mathematical performance due to sex related differences between males and females. Results seem to support Fennema and Sherman's (1978) contention that sex related mathematics performance differences do not appear often, and that when they do, are not large. However, in the Treagust (1980) and Elmore and Vasue (1980) studies sex related differences in mathematics ability were not found until high school and graduate school level respectively. Since this study used seventh, eighth, and ninth grade level students in the sample, perhaps sex related mathematics performance differences do not appear until later developmental stages. Also, since the mathematics test used in the study used the skills of estimation and comparison, it may be that there are no significant differences between the sexes on these skills but

there may be sex related differences on other mathematical abilities. In any event, considering the highly inconsistent results that research has found concerning sex related differences in mathematical ability (Fennema and Sherman, 1980; Treagust, 1980; Elmore and Vasue, 1980), further research is needed before any final conclusions can be made on sex related differences in mathematics performance.

Finally, the results of the study found no significant interactions between sex and anxiety. This finding does not support Donady and Tobias' (1977) finding of a disproportion of mathematics-anxious females. This study found a significant effect on performance of LD problems by anxiety. If Donady and Tobias' findings are correct and females are disproportionately more anxious than males toward mathematics, a significant interaction between sex and anxiety should have occured. This contradiction may indicate that, contrary to actual anxiety levels, females report higher anxiety levels and/or males report lower anxiety levels on mathematics anxiety surveys. Again, further research is definitely needed before any precise conclusions can possibly be made.

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Table I

Mathematics Performance of Subjects on High and Low Difficulty Problems.

(N's shown in parenthesis)

	Low Difficulty (LD)				High Difficulty (HD)			
	Male		Female		Male		Female	
	M	SD	M	SD	M	SD	M	SD
High Anxiety (HA)	7.80 (15)	7.06	4.80 (15)	4.99	11.67 (15)	5.35	9.33 (15)	2.04
Low Anxiety (LA)	3.93 (15)	4.40	2.33 (15)	2.58	9.47 (15)	4.07	8.60 (15)	5.20